Diffusion tensor imaging analysis using MIPAV

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Diffusion-weighted MRI uses the diffusivity of underlying structures to non-invasively map axonal tracts in the white matter of the brain. The developed application uses diffusion-weighted images and a T2-weighted image to model tractography and generate tensor statistics in an integrated pipeline. Registration algorithms have been implemented to integrate pre-processing steps, yielding a novel pipeline for efficient analysis. User tools have been developed to allow for the quantification and analysis of tractography models generated from a deterministic approach to tensor analysis. This DTI pipeline is the result of a collaborative research between the Center for Information Technology's Biomedical Imaging Research Services Section, the Clinical Center, and the Center for Neuroscience and Regenerative Medicine.

Pre-processing

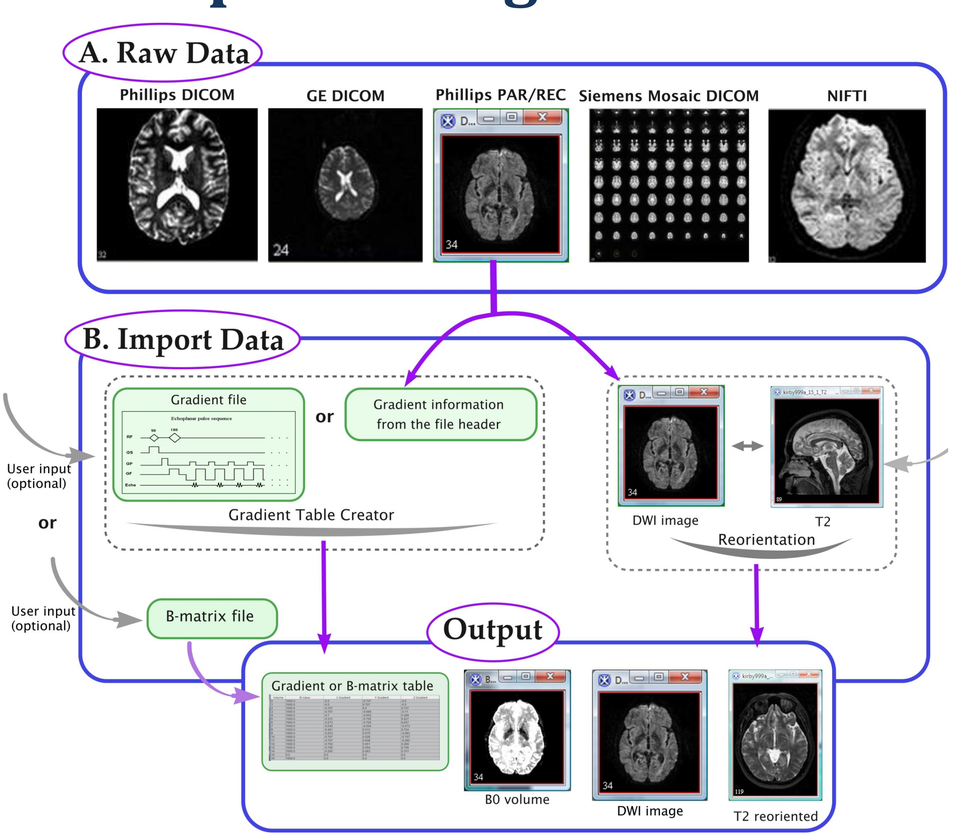

Figure 1. (A) Raw data DWI are acquired from many different MRI scanners (i.e., Siemens, Philips, and GE) in various file formats (i.e., DICOM, NIFTI, and PARREC). (B) During the import data step, the user uploads DWI and T2. Panel reads gradient or bmatrix information from header or user loaded file.

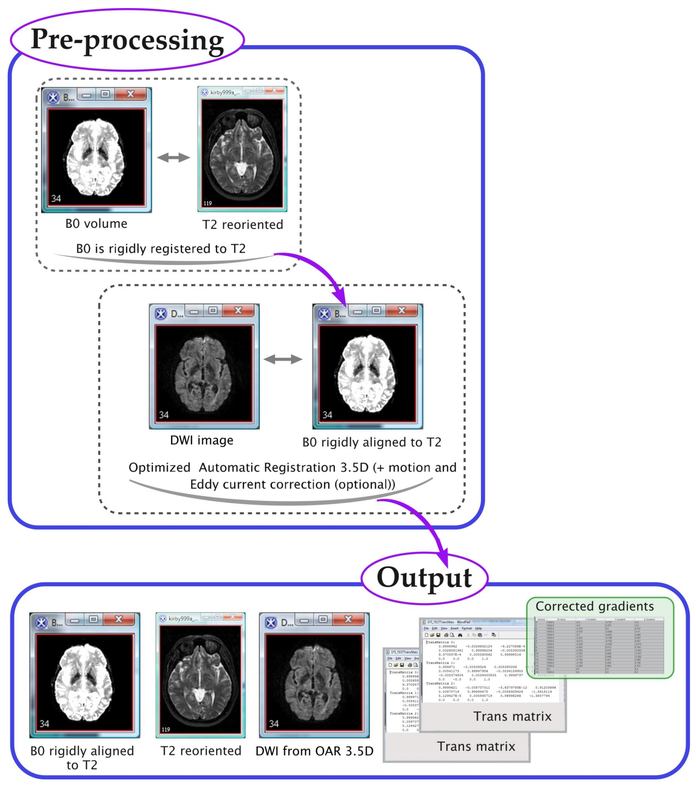

Figure 2. The pre-processing step extracts the B0 which is rigidly registered to T2. DWI is registered to rigidly aligned B0 to perform motion correction and eddy current distortion correction.

Tensor Estimation

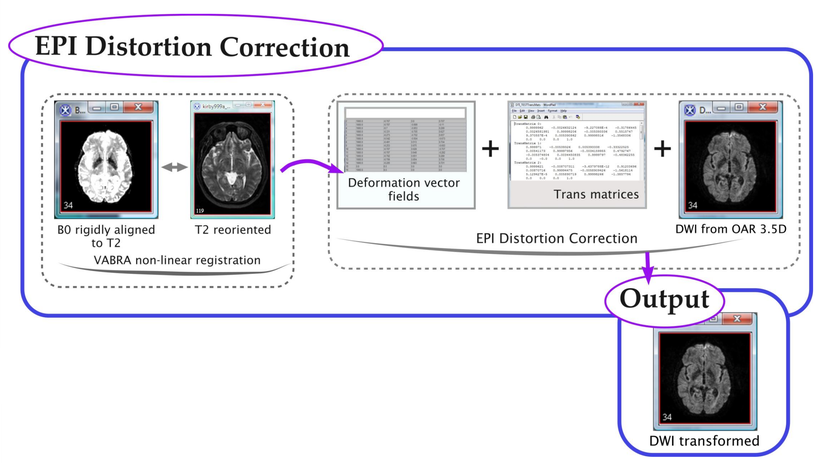

Figure 3. EPI distortion correction calculates deformation vector fields using VABRA registration from rigidly aligned B0 to T2. It uses trans matrices outputs from pre-processing and the VABRA deformation vector fields to create corrected DWI.

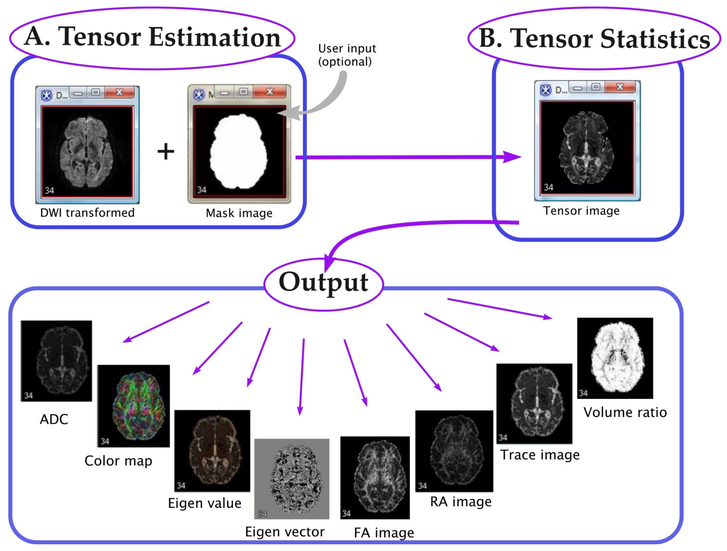

Figure 4. (A) Tensor estimation creates tensor from post-processed DWI ,bvalue/gradient information or bmatrix values, and mask image. (B) Tensor statistics uses tensor image output to create ADC, Color Map, Eigen Value, Eigen Vector, FA, RA, Trace, and Volume Ratio images.

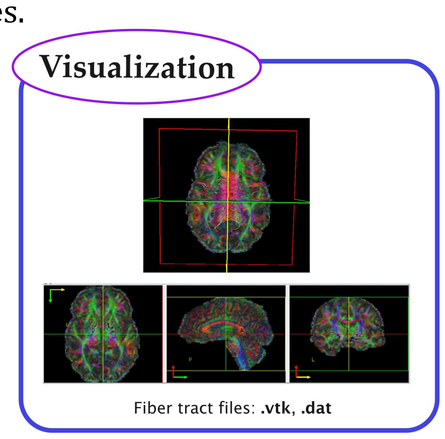

Figure 5. The visualization panel loads tensor, Color Map, Eigen Vector, Eigen Value, and FA image outputs to create 3D visualizations of fiber bundle tracts in the white matter of the brain. User can save fiber tracts in .vtk and .dat files.

Visualization

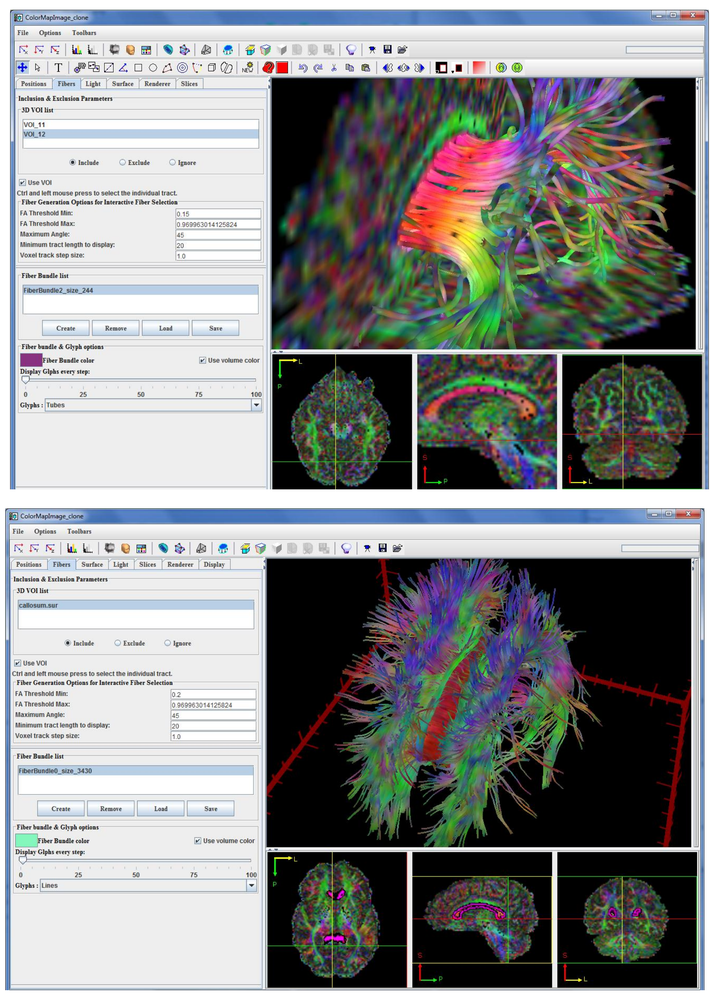

Figure 6. Deterministic modified HARDI algorithm allows specification of volumes of interest to define bounds of tractography visualization.

References

McRobbie DW, Moore EA, Graves MJ, MR Prince (2003) MRI. From picture to proton. Cambridge, UK: Cambridge University Press

Mori, Susumu (2007) Introduction to Diffusion Tensor Imaging. Amsterdam, The Netherlands: Elsevier

Acknowledgments

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